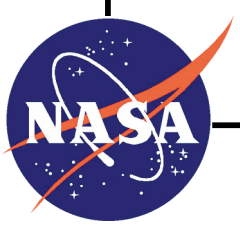
Global Precipitation Mission (GPM)

Ground Validation System

Validation Network Data Product User's Guide

DRAFT
January 12, 2007

Goddard Space Flight Center
Greenbelt, Maryland 20771



Document History

Document Version	Date	Changes
Draft	January 12, 2007	Initial draft
Draft	January 16, 2007	added updates to Figure 1-1 and Table 1-1

Contact Information

Additional information, including information on access to the password-protected ftp site referenced in this document, can be obtained from the GPM Ground Validation web site: http://gpm.gsfc.nasa.gov/groundvalidation.html.

TABLE OF CONTENTS

FIGURES AND TABLES

1. Introduction

This document provides a basic set of documentation for the data products available from the GPM Ground Validation System (GVS) Validation Network (VN). In the GPM era the VN will perform a direct match-up of GPM's space-based Dual-frequency Precipitation Radar (DPR) data with ground radar data from the US network of NOAA Weather Surveillance Radar-1988 Doppler (WSR-88D, or "NEXRAD"). The VN match-up will help evaluate the reflectance attenuation correction algorithms of the DPR and will identify biases between ground observations and satellite retrievals as they occur in different meteorological regimes. A prototype of the capability is currently in operations that performs the match-up of Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) data with ground-based NEXRAD measurements.

1.1 Data availability

VN match-up data are available on the password-protected GPM GV ftp site, the IP address of which is 128.183.212.132. Data are located in the subdirectory /PR_GV_netCDF. The username and password for this site are available on request from the points-of-contact listed on the GPM GV web site at this url: http://gpm.gsfc.nasa.gov/ground_contacts.html.

1.2 Period of record

The current period of record for the VN match-up datasets starts on August 8, 2006 and runs to the present. Because the input datasets for the VN match-ups are quality controlled by a human analyst there is a time lag of up to several weeks from observation to VN product generation.

1.3 Match-up sites

At present there 21 NEXRAD sites are included in the VN. These are all located within the southeastern US as illustrated in Figure 1-1.

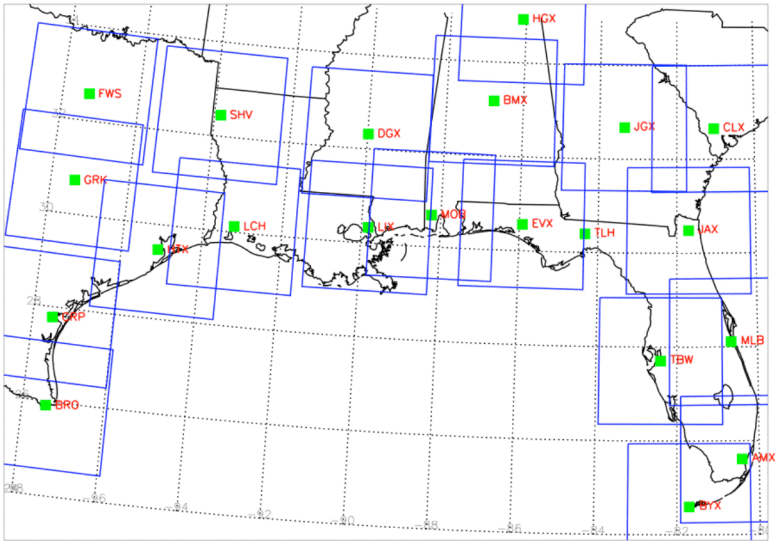


Figure 1-1. Location of VN match-up sites in the southeastern US.

The Table below lists the VN site short names, long names, and the latitude and longitude of each. The VN short names are used in the VN product file naming convention described in Section 2 of this document. Although the list below was current at the time that this document was written, it is expected that additional VN sites will be added from time to time. More up-to-date information may be available on the GPM GV web site http://gpm.gsfc.nasa.gov/groundvalidation.html. Or check with the GPM GV points-of-contact for current status.

short name	site full name	latitude	longitude
KAMX	Miami, FL	25.6111 N	80.4128 W
KBMX	Birmingham, AL	33.1722 N	86.7697 W
KBRO	Brownsville, TX	25.9161 N	97.4189 W
KBYX	Key West, FL	24.5975 N	81.7031 W
KCLX	Charleston, SC	32.6556 N	81.0422 W
KCRP	Corpus Christi, TX	27.7842 N	97.5111 W
KDGX	Jackson, MS	32.3178 N	89.9842 W
KEVX	Red Bay/Eglin AFB, FL	30.5644 N	85.9214 W
KFWS	Dallas-Ft Worth, TX	32.5731 N	97.3031 W
KGRK	Central Texas (Ft Hood), TX	30.7219 N	97.3831 W
KHGX	Houston/Galveston, TX	29.4719 N	95.0792 W
KHTX	Huntsville, AL	34.9306 N	86.0833 W
KJAX	Jacksonville, FL	30.4847 N	81.7019 W
KJGX	Robins AFB, GA	32.6753 N	83.3511 W
KLCH	Lake Charles, LA	30.1253 N	93.2158 W
KLIX	Slidell AP/New Orleans, LA	30.3367 N	89.8256 W
KMLB	Melbourne, Florida	28.1133 N	80.6542 W
KMOB	Mobile, AL	30.6794 N	88.2397 W
KSHV	Shreveport, LA	32.4508 N	93.8414 W
KTBW	Ruskin/Tampa Bay, FL	27.7056 N	82.4017 W
KTLH	Tallahassee, FL	30.3975 N	84.3289 W

Table 1-1. NEXRAD sites used in the GPM GVS Validation Network.

2. Validation Network Directory, File and Data Format

This section describes the VN directory structure and file formats, including file naming conventions.

2.1 Archive site directory

As previously described in Section 1.1, VN match-up data are available on the password-protected GPM GV ftp site, the IP address of which is 128.183.212.132. Data are located in the subdirectory /PR_GV_netCDF.

2.2 File naming convention

The VN files adhere to the file naming conventions as described below.

2.2.1 Monthly "Tape Archive" (.tar) files

Match-up grids in the /PR_GV_netCDF directory are stored as monthly .tar files according to this convention: Grids25overlap25rain.MMYY.tar. Where MM=month and YY=year. The "25overlap" part of the file name indicates that the files in the .tar archive have ≥25 percent overlap between the NEXRAD and TRMM PR coverage. The "25rain" part of the file name indicates that the files in the .tar archive have ≥25 percent confirmed rain within the overlap area.

2.2.2 Coincidence event .tar files

A number of coincidence event files are archived within each monthly .tar file. Each coincidence event file is a .tar formatted file in its own right, and each corresponds to a TRMM PR overpass that 1) matches up with a NEXRAD footprint, and 2) meets the criteria of ≥25 percent overlap between the NEXRAD and TRMM PR coverage and ≥25 percent confirmed rain within the overlap area.

The coincidence event files are named according to the convention listed below.

Example filename: grids.SHORTNAME.YYMMDD.ORBITNUMBER.tar

In this case,

SHORTNAME	= 4-chracter NEXRAD site short name (see Table 1-1)
YY	= 2-digit year
MM	= 2-digit month
DD	= 2-digit day (in UTM)
ORBITNUMBER	= 5-digit TRMM orbit number.

2.2.3 NEXRAD and PR match-up files

There are two files archived within each of the coincident event .tar files described in Section 2.2.2: one corresponding to the event NEXRAD data and one for PR data. The naming convention for this pair of files is listed below.

Example filenames: GVgrids.SHORTNAME.YYMMDD.ORBITNUMBER.nc.gz
PRgrids.SHORTNAME.YYMMDD.ORBITNUMBER.nc.gz

In this case,

SHORTNAME	= 4-chracter NEXRAD site short name (see Table 1-1)
YY	= 2-digit year
MM	= 2-digit month
DD	= 2-digit day (in UTM)
ORBITNUMBER	= 5-digit TRMM orbit number.

The designation GVgrids indicates that the content of the file includes NEXRAD data. The designation PRgrids indicates that the content of the file includes TRMM PR data. The .nc designation indicates that both files are in the netCDF format. The .gz extension indicates that both files are compressed using gzip.

2.3 Validation Network data product netCDF format

The GV (NEXRAD) and PR data products are both formatted according to the network Common Data Format (netCDF) standard. netCDF is maintained by the Unidata Program of the University Corporation for Atmospheric Research. More information on netCDF can be found on the Unidata website http://www.unidata.ucar.edu/software/netcdf/.

There are three basic components of the netCDF files termed *attributes, dimensions* and *variables*, which are described briefly below.

Attributes contain auxiliary information about each netCDF *variable*. Each *attribute* has a name, data type and length associated with it. netCDF also permits the definition of *global attributes*, but the GV and PR data products contain no such *global attributes* at this time.

Dimensions are named integers that are use to specify the size (dimensionality) of one or more *variables*.

Variables are multidimensional arrays of values of the same data type. Each *variable* has a size, type and name associated with it. *Variables* also typically have *attributes* that describe them.

2.3.1 GVgrids data format

The GVgrids files are formatted with 4 *dimensions* and 8 *variables*. Each *variable* has 2 or more *attributes* associated with it. The GVgrids netCDF *dimensions* describe the basic

grid structure of the NEXRAD radar reflectivity data that makes up the majority of the content of each file.

The NEXRAD radar reflectivity data in the GVgrids file has been resampled to 3-dimensional grid centered on the latitude and longitude of the site radar. As defined by the GVgrids *dimensions* this grid has a 4 km spacing and extends 75 grid elements due north and south, so that the grid extent is 300 km by 300 km centered on the site radar. The grid height extends in 13 vertical layers above ground level, with each layer 1.5 km thick. Thus, the overall grid extends 300 km by 300 km in the horizontal and 19.5 km in the vertical.

The GVgrids netCDF *variables* include the NEXRAD gridded data described above plus other data, including the start time of the NEXRAD volume scan, the site ID, and the site latitude and longitude. A summary is provided in Section 3 of this document of all *dimensions, attributes,* and *variables* in the GVgrids netCDF file.

2.3.2 PRgrids data format

The PRgrids files are formatted with 4 *dimensions* and 15 *variables*. Each *variable* has 1 or more *attributes* associated with it. The PRgrids netCDF *dimensions* describe the basic grid structure of the PR radar reflectivity data. The PRgrids *dimensions* are identical to those used in the GVgrids files.

The PRgrids radar reflectivity grid is identical to that described for the GVgrids, but for completeness its characteristics are re-stated here. The TRMM PR radar reflectivity data in the PRgrids file has been resampled to 3-dimensional grid centered on the latitude and longitude of the site radar. As defined by the PRgrids *dimensions* this grid has a 4 km spacing and extends 75 grid elements due north and south, so that the grid extent is 300 km by 300 km centered on the NEXRAD radar that the PRgrid is associated with. The PRgrids grid height extends in 13 vertical layers above ground level, with each layer 1.5 km thick. Thus the overall grid extends 300 km by 300 km in the horizontal and 19.5 km in the vertical.

The PRgrids netCDF *variables* include the 3-dimensional grids (as described above) of Level 1C-21 TRMM PR uncorrected reflectivity, TRMM PR 2A25 attenuation-corrected radar reflectivity, TRMM 2A-25 estimated rain rate. In addition, there are a number 2-dimensional grids including those for a land/ocean flags, near-surface rain rate, bright band height, a yes/no rain flag, and rain type (stratiform, convective, or other). As with the 3-dimensional grids, the 2-dimensional grids are centered on the NEXRAD radar location, have a 4 km grid spacing running due north-south, and extend for 300 km by 300 km. Other *variables* in the PRgrids netCDF file include the time of the nearest approach of the TRMM PR scan to the NEXRAD site, the site ID of the associated NEXRAD station, and the NEXRAD site latitude and longitude. A summary is provided in Section 4 of this document of all *dimensions, attributes,* and *variables* in the GVgrids netCDF file.

3. Summary of the GVGrids Data Format

number of global attributes 0

number of dimensions 4

dimension 0
NAME xdim
SIZE 75
dimension 1
NAME ydim
SIZE 75
dimension 2
NAME Height
SIZE 13
dimension 3
NAME len_site_ID
SIZE 4

number of variables 8

VARIABLE 0
NAME Height
DATA TYPE SHORT
NUMBER OF DIMENSIONS 1
NUMDER OF ATTRIBUTES 2
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE CAPPI Height Levels in 3-D Cartesian grid
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE meters

VARIABLE 1
NAME dx
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 2
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Cartesian grid spacing in x-direction
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE meters

VARIABLE 2
NAME dy
DATA TYPE FLOAT

```
NUMBER OF DIMENSIONS   0
NUMDER OF ATTRIBUTES   2
 ATTRIBUTE NUMBER   0
   ATTRIBUTE NAME long_name
   ATTRIBUTE VALUE Cartesian grid spacing in y-direction
 ATTRIBUTE NUMBER   1
   ATTRIBUTE NAME units
   ATTRIBUTE VALUE meters

VARIABLE   3
NAME threeDreflect
DATA TYPE FLOAT
NUMBER OF DIMENSIONS   3
NUMDER OF ATTRIBUTES   3
 ATTRIBUTE NUMBER   0
   ATTRIBUTE NAME long_name
   ATTRIBUTE VALUE 2A-55 GV radar Reflectivity
 ATTRIBUTE NUMBER   1
   ATTRIBUTE NAME units
   ATTRIBUTE VALUE dBZ
 ATTRIBUTE NUMBER   2
   ATTRIBUTE NAME _FillValue
   ATTRIBUTE VALUE      -99.9900

VARIABLE   4
NAME beginTimeOfVolumeScan
DATA TYPE DOUBLE
NUMBER OF DIMENSIONS   0
NUMDER OF ATTRIBUTES   3
 ATTRIBUTE NUMBER   0
   ATTRIBUTE NAME units
   ATTRIBUTE VALUE seconds
 ATTRIBUTE NUMBER   1
   ATTRIBUTE NAME long_name
   ATTRIBUTE VALUE Seconds since 01-01-1970 00:00:00 UTC
 ATTRIBUTE NUMBER   2
   ATTRIBUTE NAME _FillValue
   ATTRIBUTE VALUE       0.0000000

VARIABLE   5
NAME site_ID
DATA TYPE CHAR
NUMBER OF DIMENSIONS   1
NUMDER OF ATTRIBUTES   1
 ATTRIBUTE NUMBER   0
   ATTRIBUTE NAME long_name
   ATTRIBUTE VALUE ICAO ID of WSR-88D Site
```

VARIABLE 6
NAME site_lat
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Latitude of Ground Radar Site
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE degrees North
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -999.000

VARIABLE 7
NAME site_lon
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Longitude of Ground Radar Site
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE degrees East
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -999.000

4. Summary of the PRGrids Data Format

number of global attributes 0

number of dimensions 4

dimension 0
NAME xdim
SIZE 75
dimension 1
NAME ydim
SIZE 75
dimension 2
NAME Height
SIZE 13
dimension 3
NAME len_site_ID
SIZE 4

number of variables 15

VARIABLE 0
NAME Height
DATA TYPE SHORT
NUMBER OF DIMENSIONS 1
NUMDER OF ATTRIBUTES 2
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE CAPPI Height Levels in 3-D Cartesian grid
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE meters

VARIABLE 1
NAME dx
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 2
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Cartesian grid spacing in x-direction
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE meters

VARIABLE 2
NAME dy
DATA TYPE FLOAT

NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 2
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Cartesian grid spacing in y-direction
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE meters

VARIABLE 3
NAME dBZnormalSample
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 3
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE 1C-21 Uncorrected Reflectivity
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE dBZ
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -99.9900

VARIABLE 4
NAME correctZFactor
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 3
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE 2A-25 Attenuation-corrected Reflectivity
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE dBZ
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -99.9900

VARIABLE 5
NAME rain
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 3
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE 2A-25 Estimated Rain Rate
ATTRIBUTE NUMBER 1

```
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE mm/h
  ATTRIBUTE NUMBER  2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE     -99.9900

VARIABLE  6
NAME landOceanFlag
DATA TYPE SHORT
NUMBER OF DIMENSIONS  2
NUMDER OF ATTRIBUTES  3
  ATTRIBUTE NUMBER  0
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE 1C-21 Land/Ocean Flag
  ATTRIBUTE NUMBER  1
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE Categorical
  ATTRIBUTE NUMBER  2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE     2048

VARIABLE  7
NAME nearSurfRain
DATA TYPE FLOAT
NUMBER OF DIMENSIONS  2
NUMDER OF ATTRIBUTES  3
  ATTRIBUTE NUMBER  0
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE 2A-25 Near-Surface Estimated Rain Rate
  ATTRIBUTE NUMBER  1
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE mm/h
  ATTRIBUTE NUMBER  2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE     -99.9900

VARIABLE  8
NAME BBheight
DATA TYPE FLOAT
NUMBER OF DIMENSIONS  2
NUMDER OF ATTRIBUTES  3
  ATTRIBUTE NUMBER  0
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE 2A-25 Bright Band Height from Range Bin Numbers
  ATTRIBUTE NUMBER  1
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE m
  ATTRIBUTE NUMBER  2
```

```
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE      -99.9900

VARIABLE   9
NAME rainFlag
DATA TYPE SHORT
NUMBER OF DIMENSIONS   2
NUMDER OF ATTRIBUTES   3
  ATTRIBUTE NUMBER   0
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE 2A-25 Rain Flag (bitmap)
  ATTRIBUTE NUMBER   1
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE Categorical
  ATTRIBUTE NUMBER   2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE     2048

VARIABLE  10
NAME rainType
DATA TYPE SHORT
NUMBER OF DIMENSIONS   2
NUMDER OF ATTRIBUTES   3
  ATTRIBUTE NUMBER   0
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE 2A-23 Rain Type (stratiform/convective/other)
  ATTRIBUTE NUMBER   1
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE Categorical
  ATTRIBUTE NUMBER   2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE     2048

VARIABLE  11
NAME timeNearestApproach
DATA TYPE DOUBLE
NUMBER OF DIMENSIONS   0
NUMDER OF ATTRIBUTES   3
  ATTRIBUTE NUMBER   0
    ATTRIBUTE NAME units
    ATTRIBUTE VALUE seconds
  ATTRIBUTE NUMBER   1
    ATTRIBUTE NAME long_name
    ATTRIBUTE VALUE Seconds since 01-01-1970 00:00:00
  ATTRIBUTE NUMBER   2
    ATTRIBUTE NAME _FillValue
    ATTRIBUTE VALUE       0.0000000
```

VARIABLE 12
NAME site_ID
DATA TYPE CHAR
NUMBER OF DIMENSIONS 1
NUMDER OF ATTRIBUTES 1
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE ICAO ID of WSR-88D Site

VARIABLE 13
NAME site_lat
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Latitude of Ground Radar Site
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE degrees North
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -999.000

VARIABLE 14
NAME site_lon
DATA TYPE FLOAT
NUMBER OF DIMENSIONS 0
NUMDER OF ATTRIBUTES 3
ATTRIBUTE NUMBER 0
ATTRIBUTE NAME long_name
ATTRIBUTE VALUE Longitude of Ground Radar Site
ATTRIBUTE NUMBER 1
ATTRIBUTE NAME units
ATTRIBUTE VALUE degrees East
ATTRIBUTE NUMBER 2
ATTRIBUTE NAME _FillValue
ATTRIBUTE VALUE -999.000

5. Acronyms and Symbols

ACRONYM	DEFINITION
3-D	3-Dimension
AGL	Above Ground Level
DPR	Dual-frequency Precipitation Radar
GPM	Global Precipitation Measurement
GSFC	Goddard Space Flight Center
GV	Ground Validation
GVS	Ground Validation System
ID	Identification
IP	Internet Protocol
km	kilometer
NASA	National Aeronautics and Space Administration
netCDF	network Common Data Form
NEXRAD	Next-generation Radar
PMM	Precipitation Measuring Missions
PR	Precipitation Radar
QC	Quality Control
TRMM	Tropical Rainfall Measuring Mission
US	United States
UTC	Coordinated Universal Time
VN	Validation Network
WSR-88D	Weather Surveillance Radar - 1988 Doppler